

**AMENDMENTS TO THE SPECIFICATION:**

Page 1, please add the following new paragraphs before paragraph [0001]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 USC 371 application of PCT/DE 2004/000743  
filed on April 8, 2004.

[0000.6] BACKGROUND OF THE INVENTION

Please replace paragraph [0003] with the following amended paragraph:

[0003] ~~Background of the Invention~~ **Description of the Prior Art**

Please replace paragraph [0004] with the following amended paragraph:

[0004] German Patent Disclosure DE 101 23 913 A1 ~~has~~ **discloses** a fuel injection system for internal combustion engines with a fuel injector that can be supplied from a high-pressure fuel source ~~as its subject~~. A pressure booster device having a movable pressure booster piston is connected between the fuel injector and the high-pressure fuel source. The pressure booster piston divides a chamber, which can be made to communicate with the high-pressure fuel source, from a high-pressure chamber that communicates with the fuel injector. For filling a differential pressure chamber of the pressure booster device with fuel or evacuating the differential pressure chamber of fuel, the fuel pressure in the high-pressure chamber can be varied. The fuel injector has a movable closing piston for opening and closing injection openings. The closing piston protrudes into a closing-pressure chamber, so that the closing piston can be acted upon by fuel pressure to attain a force acting in the closing direction on the closing piston. The closing-pressure chamber and the differential pressure chamber are formed by a common closing-pressure differential pressure chamber, and all the portions of

the closing-pressure differential pressure chamber communicate permanently with one another from exchanging fuel. A pressure chamber is provided for supplying the injection openings with fuel and for subjecting the closing piston to a force acting in the opening direction. A high-pressure chamber communicates with the high-pressure fuel source in such a way that aside from pressure fluctuations, at least the fuel pressure of the high-pressure fuel source can be applied constantly to the high-pressure chamber; the pressure chamber and the high-pressure chamber are formed by a common injection chamber. All the portions of the injection chamber communicate permanently with one another for exchanging fuel.

Page 2, please replace paragraph [0005] with the following amended paragraph:

[0005] ~~From~~ German Patent Disclosure DE 102 47 903.8 A1[[,]] discloses a pressure-amplified fuel injection system with an internal control line ~~can be learned~~. The fuel injection system, which communicates with a high-pressure source, has a multi-part injector body. In it, a pressure booster that can be actuated via a differential pressure chamber is received, and its pressure booster piston divides a work chamber from the differential pressure chamber. The fuel injection system is actuatable via a switching valve. A change in pressure in the differential pressure chamber of the pressure booster is effected via a central control line, which extends through the pressure booster piston. The central control line is passed through the work chamber of the pressure booster and is sealed off from it via a high-pressure-proof connection.

Page 4, please replace paragraph [0008] with the following amended paragraph:

[0008] ~~Summary of the Invention~~     **SUMMARY OF THE INVENTION**

Page 5, please replace paragraph [0011] with the following amended paragraph:

[0011] By means of suitable shaping of the groove or of the cylindrically shaped pocket, specific shapes of the opening can thus be achieved that are geometrically oval, rectangular, or otherwise-shaped. By means of a defined shape of the opening, the stresses in the region of the high-pressure intersection point between the groove and the control line embodied as a bore, or between the cylindrically shaped pocket and the control line embodied as a bore, can be varied in a purposeful way and ~~additional~~ **additionally** reduced still further. With connection points embodied in this way in the high-pressure region between high-pressure chambers of components that are exposed to extreme pressures, on the one hand, over the long term, the service lives of fuel injectors with pressure amplifiers can be ~~shortened~~ **increased** because of the lower stress level; on the other hand, by means of the connection proposed according to the invention of high-pressure chambers of components carrying extremely high pressure, it is possible to increase the injection pressure ~~amplifier~~ **amplified** in fuel injectors still further.

Please replace paragraph [0012] with the following amended paragraph:

[0012] ~~Drawings~~     **BRIEF DESCRIPTION OF THE DRAWINGS**

Please replace paragraph [0013] with the following amended paragraph:

[0013] The invention is described in detail below, in conjunction with the drawings[[.]] **in which:**

Applicant: Heinz HAISER et al.  
Docket No. R.306015  
Preliminary Amdt.

Please delete paragraph [0014].

Please replace paragraph [0015] with the following amended paragraph:

[0015] Fig. 1[[,]] **is a sectional view of** a pressure amplifier, activated via pressure variations in a differential pressure chamber, in the nonactivated state;

Please replace paragraph [0017] with the following amended paragraph:

[0017] Fig. 3[[,]] **is a sectional view, in perspective, of** a pressure amplifier ~~in half-section~~, whose differential pressure chamber communicates by means of a horizontal bore with a control line embodied as a bore;

Please replace paragraph [0018] with the following amended paragraph:

[0018] Fig. 4[[,]] **is a view similar to Fig. 3 showing** a connection configured according to the invention of a differential pressure chamber in the body of the pressure amplifier, with a control line embodied as a bore[[,]] ~~again in half-section~~;

Page 6, please replace paragraph [0019] with the following amended paragraph:

[0019] Fig. 5[[,]] **is** a developed boundary wall of a pressure chamber, in which a cylindrically shaped pocket is embodied that with a control line embodied as a bore forms a connection;

Please replace paragraph [0020] with the following amended paragraph:

[0020] Fig. 6[[,]] **is** a developed boundary wall of a high-pressure container, in which an encompassing groove, also shown in a developed view, is made that likewise communicates with a control line embodied as a bore;

Please replace paragraph [0021] with the following amended paragraph:

[0021] Fig. 7.1[[,]] **is a sectional view of** a connection of a differential pressure chamber of a pressure amplifier to a control line embodied as a bore;

Please replace paragraph [0022] with the following amended paragraph:

[0022] Fig. 7.2[[,]] **is a view similar to Fig. 7.1 of** a connection configured according to the invention of a control line embodied as a bore to the differential pressure chamber of a pressure amplifier; and

Please replace paragraph [0023] with the following amended paragraph:

[0023] Fig. 7.3[[,]] **is** a connection embodied as an encompassing groove, of a differential pressure chamber of a pressure amplifier, with a control line embodied as a bore.

Please replace paragraph [0024] with the following amended paragraph:

[0024] **Variant Embodiments**

## **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Page 8, please replace paragraph [0026] with the following amended paragraph:

[0026] A pressure amplifier 1 includes a work chamber 2 and a differential pressure chamber 4 that can be relieved of pressure or subjected to pressure. The pressure amplifier 1 further includes a compression chamber 5 embodied in the body 11 of the pressure amplifier. The amplifier piston 3 that divides the differential pressure chamber 4 from the work chamber 2 includes a first end face 6 and a second end face 7 that defines the compression chamber 5. Via a high-pressure source, not further shown in Fig. 1, the work chamber 2 of the pressure amplifier 1 is subjected to system pressure ( $p_{\text{rail}}$ ). The system pressure ( $p_{\text{rail}}$ ) also prevails in

the differential pressure chamber 4, ~~in~~ **In** the compression chamber 5 of the pressure amplifier 1, which is shown in its deactivated position 8 in Fig. 1, system pressure level  $p_{\text{rail}}$  also prevails. The pressure amplifier 1 is accordingly in pressure equilibrium, since the pressure forces applied to the second end face 7 and to the annular face in the differential pressure chamber 4 of the pressure amplifier 1 correspond to the pressure force engaging the first end face 6 of the amplifier piston 3.

Page 8, please delete paragraph [0027].

Please replace paragraph [0028] with the following amended paragraph:

[0028] **Fig. 2 shows the pressure amplifier of in Fig. 1, but in its activated state.**

Via a pressure relief of the differential pressure chamber 4 to a pressure level  $p_{\text{fuel,return}}$ , the amplifier piston 3, because of the pressure force in the work chamber 2, which is generated by the system pressure ( $p_{\text{rail}}$ ) and engages the first end face 6 of the amplifier piston, moves into the compression chamber 5. The second end face 7, which defines the compression chamber 5 of the pressure amplifier 1, compresses the fuel supply contained in the compression chamber 5 to an elevated pressure level ( $p_{\text{amplified}}$ ), which is attainable in accordance with the design ratio of the pressure amplifier piston 3, which is carried in the region of an inlet 10 to an injection valve member, not shown in Fig. 2.

Page 9, please delete paragraph [0029].

Please replace paragraph [0030] with the following amended paragraph:

[0030] **Fig. 3 shows a half-section through a body of a pressure amplifier of the prior art.** The pressure amplifier 1 includes a body 11, in which a control line 12 embodied as a bore extends. The control line 12 embodied as a bore communicates with the differential pressure chamber 4 of the pressure amplifier 1 via a horizontal bore 13. The horizontal bore 13 is a critical region in terms of the stress level that is established in operation of the pressure amplifier 1. Within the critical region 14, also called an intersection region, both a first intersection point 15 with the control line 12 embodied as a bore and with the horizontal bore 13 and a second, critical intersection point 16 between the horizontal bore 13 and the differential pressure chamber 4 of the pressure amplifier 1 develop. In operation of the pressure amplifier 1, the greatest stresses occur at these intersection points 15 and 16 and decisively impair the durability of this kind of pressure amplifier 1 with a horizontal bore 13. The compression chamber 5 is shown in half-section through the body 11 of the pressure amplifier 1 in the view in Fig. 3, and from it, at an angle that depends on the design of the pressure amplifier 1, the inlet 10 branches off to an injection valve member, not shown in Fig. 3.

Please delete paragraph [0031].

Page 10, please replace paragraph [0032] with the following amended paragraph:

[0032] **Fig. 4 shows a variant embodiment of the invention of a connection between the control line 12, embodied as a bore, and a differential pressure chamber of a pressure amplifier.** It can be seen ~~from the view in Fig. 4~~ that at the lower end of the differential

pressure chamber 4 of the pressure amplifier 1, an encompassing groove 18 or a cylindrically shaped pocket 19 may be embodied. ~~At a first bore intersection 17, in~~ **In** accordance with the embodiment proposed according to the invention, between the encompassing groove 18 or the cylindrically shaped pocket 19, a first bore intersection 17 is established, while a second bore intersection 22 is formed between the differential pressure chamber 4 of the pressure amplifier 1 and the cylindrically shaped pocket 19 or the encompassing groove 18. The differential pressure chamber 4 is defined on its lower end by an annular face 20; the compression chamber 5 is shown in half-section in Fig. 4 on the lower end of the body 11 of the pressure amplifier 1, and from it, at an angle of inclination, ~~an~~ **of** the inlet 10[,] branches off to the injection valve member, not shown in Fig. 4.

Please replace paragraph [0033] with the following amended paragraph:

[0033] The view in Fig. 5 shows a boundary wall, shown in [[an]] **a developed**, extended position of 180°, of a high-pressure container with a cylindrically shaped pocket.

Please replace paragraph [0034] with the following amended paragraph:

[0034] In the **developed** view **of** [[in]] Fig. 5, the boundary wall of the differential pressure chamber 4 of a pressure amplifier is shown in a 180° extended position. The tangential stresses caused in the body 11 of the pressure amplifier 1 by the internal pressure in the differential pressure chamber 4 act[,] ~~in the block shown in developed view in Fig. 5,~~ as tensile stresses represented by the two arrows pointing away from one another. In the region in which two bores would meet one another, the notch effects that occur at the intersection point 15 in Fig. 3 are added together along the bores 12 and 13, the result being a pronounced excessive increase in stress. In the view in Fig. 5, **however**, the connection of the control line

12, embodied as a bore, to the differential pressure chamber 4 is embodied as a cylindrically shaped pocket 19, which does not exhibit any notch effect. In comparison to the connection of the differential pressure chamber 4 to the control line 12 embodied as a bore in Fig. 3 by means of a horizontal bore 13, the embodiment of the connection according to the invention as shown in Fig. 5 produces only one notch effect point 23 along the bore 12, at which, in comparison to the two notch effect points 15 and 16 that result in Fig. 3, a considerably lesser stress level is established.

Page 11, please delete paragraph [0035].

Please replace paragraph [0036] with the following amended paragraph:

[0036] **In the view in Fig. 6, the connection of a high-pressure chamber by means of an encompassing groove to a control line embodied as a bore is shown. In the variant this** embodiment ~~shown in Fig. 6~~ of a connection of a high-pressure chamber to a control line 12 embodied as a bore, an encompassing groove 18 shown in a developed view is let into a wall 21, also shown in a developed view, of a high-pressure chamber, such as a differential pressure chamber 4 of a pressure amplifier 1. The encompassing groove 18 is free of notch effects; along the bore 12, the notch effect point 23 forms, which represents the location where the maximum stresses 24 occur. The tangential stresses that occur in the component, that is, in the body 11, are also shown in the view in Fig. 6, as tensile stresses in the developed **view of the wall** position 21 of the body 11.

Page 12, please replace paragraph [0038] with the following amended paragraph:

[0038] By comparison, an encompassing groove 18 as in Fig. 6 does weaken the total cross section of the body 11 somewhat, but with a view to the resultant mechanical load, the encompassing groove 18 does not act like a notch under tensile stress. As a result, an excessive increase in stress at the notch effect point 23 is avoided, so that only one notch effect point 23 is embodied, which represents the location 23 where the maximum stresses occur. In comparison to the variant embodiment of Fig. 3 where the connection is designed as a horizontal bore 13, however, a considerably lesser stress level is established at the notch effect point 23. If conversely the connection between the control line 12 embodied as a bore and a container carrying high pressure is designed as a cylindrically shaped pocket 19, this variant embodiment of the connection offers the advantage that the cylindrically shaped pocket 19 results in a lesser idle volume in comparison to an encompassing groove 18; that is, the high-pressure container can be filled with a lesser volume if the connection is embodied as a cylindrically shaped pocket 19. If the idle volume, for instance in the differential pressure chamber 4 of the pressure amplifier 1, can be reduced, this advantageously leads to an increase in efficiency; moreover, the hydraulic adaptation can be improved, and last but not least - in the case of a pressure amplifier - smaller diversion quantities are moved upon activation of the pressure amplifier.

Page 13, please delete paragraph [0039].

Please replace paragraph [0040] with the following amended paragraph:

[0040] **Fig. 7.1 shows a connection of a differential pressure chamber to a control line, embodied as a bore, by means of a horizontal bore.** The differential pressure chamber 4 is embodied symmetrically to an axis of symmetry 25. The control line 12 and the differential pressure chamber 4 communicate with one another via the horizontal bore 13, so that the first intersection point 15 results between the horizontal bore 13 and the control line 12, and the second intersection point 16 is represented ~~[[by]]~~ **at** the horizontal bore 13 and the differential pressure chamber 4. The notch effects that form at the intersection point 15 are added together, resulting in a first, very high stress level  $\sigma_{\max, I}$  during operation of the pressure amplifier.

Please delete paragraph [0041].

Please replace paragraph [0042] with the following amended paragraph:

[0042] **In the view shown in Fig. 7.2, the connection of the differential pressure chamber to the control line embodied as a bore is embodied by a cylindrically shaped pocket.** The cylindrically shaped pocket 19 is molded into the inner wall in the lower region of the differential pressure chamber 4. The cylindrically shaped pocket 19 forms the connection point between the control line 12, embodied as a bore, and the differential pressure chamber 4 in the body 11. The control line 12 can be embodied as either a blind bore (Fig. 7.1) or a through bore 12.1. Because of the shape of the connection point as a cylindrically shaped pocket 19, a first bore intersection 17 is established, which represents the notch effect point 23. In ~~comparison~~ **contrast** to the view in Fig. 7.1, only one notch effect contribution by the bore intersection 17 is shown. This notch effect point 23 represents the

location 24 where a maximum stress  $\sigma_{\max,2}$  occurs, which is considerably below the additive maximum stress  $\sigma_{\max,1}$  that occurs in Fig. 7.1. As a result, in operation of a high-pressure container, such as a differential pressure chamber 4 of a pressure amplifier, the stress level that occurs in its body 11 can be reduced by up to 30%. The cylindrically shaped pocket 19 is molded in the lower region of the inner wall of the differential pressure chamber 4 in the body 11 and moreover ~~offers~~ **produces** an only slight increase in the idle volume inside the differential pressure chamber 4. The maximum height of the cylindrically shaped pocket 19 is represented by reference numeral 30; the cylindrically shaped pocket 19 extends symmetrically and semicircularly and ends in ending regions 31 in the inner wall of the differential pressure chamber 4. The notch effect that occurs at the second bore intersection 22 between the cylindrically shaped pocket 19 and the wall of the differential pressure chamber 4 is negligible, compared to the excessive increase in stress caused by the notch effect at the first bore intersection 17.

Page 14, please delete paragraph [0043].

Please replace paragraph [0044] with the following amended paragraph:

[0044] **Fig. 7.3 shows the embodiment in cross section, in which the connection of the control line embodied as a bore to the differential pressure chamber is effected via an encompassing groove in the body subjected to pressure.** In this variant embodiment, the encompassing groove 18, which is embodied with a constant height 32, forms a first bore intersection 17. The first bore intersection 17 marks the transition point from the control line 12 embodied as a bore to the encompassing groove 18; a second bore intersection 22 is also

established, which represents the transitional region between the differential pressure chamber 4 and the encompassing groove 18. The lower annular face of the encompassing groove 18 is identified by reference numeral 20. Further bores 33 may be connected to the encompassing groove 18, of which one is shown in Fig. 7.3. The intersection 17 between the control line 12 embodied as a bore and the encompassing groove 18 represents the notch effect point 23, which represents the location 24 of the maximum stress  $\sigma_{\max,3}$ . In comparison to the maximum stress  $\sigma_{\max,2}$  that occurs in the variant embodiment of Fig. 2, the maximum stress  $\sigma_{\max,3}$  that occurs in the variant embodiment of Fig. 7.3 is reduced still further.

Page 15, please add the following new paragraph after paragraph [0046]:

[0047] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Please delete pages 16 and 17.